Electrode liner tube

The present invention relates to a filler wire guide tube according to the preamble of patent claim 1 for feeding filler wire in a MIG welding apparatus.

In MIG welding, the welding current circuit is established via the filler wire or core-flux wire and the workpiece. The filler wire is fed continuously into the weld puddle, whereby it forms the weld bead as it cools down with the metal molten from the workpiece. The filler wire must be basically of the same material as the workpiece and also in demanding welds, the alloy composition of the filler wire should be as close as possible to that of the workpiece. The most commonly used filler wire materials are steel, stainless steel and aluminum. Welding may also be carried out using core-flux wire that in its center has additives capable of controlling the behavior of the weld puddle. The filler wire is fed via a welding gun whereto it is passed along a tubular wire guide conduit. The wire feed mechanism generally resides in the welding apparatus wherefrom the mechanism pushes the filler wire forward in the wire guide tube. The wire guide tube must be made rather long to give the welder a sufficiently large operating area. In manual welding equipment, even apparatuses intended for nonprofessional use must have a wire guide at least 2 to 3 m long and in professional equipment even substantially longer. Automatic welding equipment, e.g., implemented as robotic welding systems must have very long wire guides, even in excess of 10 m.

The filler wire diameter is typically 0.8 – 1.6 mm, and the stiffness of the wire is dependent on its material. Inasmuch as thin filler wires in particular are extremely flexible, the wire guide must give support to the wire during its travel. Since the wire feed normally takes place by a pushing action, the wire cannot be tensioned for secure conveyance. Hence, after leaving the feed roller, the wire seeks support from inner wall of the wire guide liner so that the outer surface of the wire glides along liner inner wall. As a result, dirt from the wire surface and debris of the wire material itself adhere to the liner inner wall during welding thus forming agglomerations that

jam the travel of the wire. After a sufficient amount of dirt/debris has accumulated on the liner inner wall, the mechanical resistance to the filler wire travel increases and the wire feed speed begins to fluctuate so much as to make welding sticky, in which situation it may become problematic to achieve a suffiently good weld quality. Since the wire guide is rather long, even the smallest dirt agglomerations rapidly increase the mechanical resistance to the wire travel eventually leading to a plugged wire guide that needs careful cleaning or replacement with a new guide.

Another problem hampering filler wire feed is caused by the bending of the wire guide. If the wire guide is distorted by one or more sharp bends, the mechanical resistance to filler wire feed increases substantially thus frequently stopping filler wire feed. Yet, the wire guide tube must be designed flexible enough to allow taking the welding gun to workplaces sometimes very difficult to reach.

Plural attempts have been made to overcome the above-described problems. In SE Pat. Appl. No. 8504966-6 is described a flexible wire guide having its inner liner comprised of a string of successive glass rings. This arrangement provides a flexible guide construction whose inner liner is resistant to wear. However, the glass rings are brittle and even one broken ring fouls the wire guide conduit. Such a wire guide construction is also very expensive to manufacture. In SE Pat. No. 354,597 is further described a wire guide structure having the cross section of the wire guide lumen shaped triangular or in the shape of an inwardly three-pointed star. As a result, the area of the wire guide inner surface contacting the wire becomes small, whereby the mechanical resistance to wire feed is low. A problem of this wire guide structure is that it is suitable for one wire diameter only and, due to its small contact surface with the wire, the wear rate of the plastic liner of the wire guide is rapid. The wire guide may also be implemented using a flexible, metallic, helical conduit or having a spring-like outer jacket or some other bendable structure. Such wire guide structures are disclosed in patent publications NO 130894, JP 19840197178, CH 421340 and US 2,694,130. Also these structures are hampered by high mechanical friction and resistance of filler wire feed, as well as fouling of the wire guide liner due to accu-

mulation of dirt and wire material. Many of these structures are also very complicated due to their multilayer construction comprising plural metal and jacket portions.

It is an object of the invention to provide a filler wire guide offering a wire travel friction lower than that of prior-art ducts, reduced accumulation of debris on the duct inner wall and a sufficiently high bending resistance to prevent formation of sharp bends on the wire guide.

The goal of the invention is achieved by way of forming the wire guide from a two-layer plastic material having its outer layer made from high-density polyethylene and the inner layer serving as the actual wire guide liner from polyethylene blended with at least particulate polytetrafluoroethylene (PTFE).

More specifically, the filler wire guide duct in accordance with the invention is characterized by what is stated in the characterizing part of patent claim 1.

The invention offers significant benefits.

The mechanical resistance of the wire guide in accordance with the invention to the filler wire travel is extremely low, even lower than the wire travel friction in a wire guide having its liner made entirely of PTFE. The structure of the present wire guide is extremely simple inasmuch as it comprises an integral uniform conduit only. Hence, the present wire guide structure is very cost-effective to manufacture as compared with wire guides comprising a separate flexible jacket on a wire guide incorporating a glide surface. Having the outer layer of the wire guide made of a stiff and hard material, the guide cannot accidentally bend into a sharp kink when the welding gun at the distal end of the guide is moved during welding operations. As a result, reliable filler wire feed is assured. The wire guide according to the invention accumulates substantially less dirt and filler wire material on its inner wall thus giving the wire guide a long service life and securing smooth wire feed even after long-term use. The wire guide can be manufactured by plastic pipe extruders as two-

layer extrusion. Suitable extruder equipment for this purpose are readily available.

In the following, the invention is examined with the help of exemplary embodiments.

The wire guide according to the invention comprises two layers that during the wire guide coextrusion become integrally bonded to each other. While layers of the wire guide need not necessarily be separate, concurrent technologies have difficulties in single-step extrusion of a single-layer conduit having only its inner wall blended with an additive. The only essential characterizing feature of the invention can be stated as follows: the surface of the wire guide inner wall has an annular region that contains an additive, while the surrounding region is free from the additive. For simplicity, however, the following description discusses two separate layers.

The outer layer of the wire guide is made of high-density polyethylene (HDPE) that forms a sufficiently stiff reinforcing layer and gives sufficient stiffness required from the wire guide. That is, the wire guide must have quite good stiffness to prevent the wire guide from bending into an excessively small radius. The inner surface of the wire guide wall has a glide layer that also basically is of high-density polyethylene. To the base material of the glide layer is blended about 15 % of an additive comprising polytetrafluoroethylene and silicon micropowder. In the glide layer, the amount of PTFE in the weight of the glide layer is about 13 wt. %, while the amount of silicon micropowder is 1 – 2 wt. %. The variation range of additives is: overall amount of additive 12 – 20 wt. %, wherein PTFE 12 – 17 wt. % and silicon 1 – 3 wt. %. Additional additives may comprise molybdenum sulfide, advantageously in particulate form, in order to improve the inherently good glide and antistick properties of the inner layer. Both of the additives are used in powderized form thus having an extremely small particle size. PTFE gives the inner layer good glide properties and silicon powder promotes correct distribution of particulate PTFE in the base material of the glide layer. The silicon powder also performs as a stabilizer of the glide properties of the inner layer. The composition described above provides a hard and durable glide layer that simultaneously has good glide properties. The

glide layer is made about 300 – 400 μm thick. The inner diameter of the guide tube lumen may be varied according to the application, whereby in conjunction with conventionally used filler wires the wire guide inner diameter is selected to be in the range of 2 – 4 mm and the outer diameter respectively in the range of 4 – 7 mm. As the wire guide outer diameter is rather small, it is extremely important that the outer layer providing the structural stiffness is sufficiently strong.

The wire guide tube is manufactured, e.g., by extruding the first layer of blended material through the annular orifice formed between the tube-forming mandrel and die, whereupon the unblended outer layer is extruded on the first layer in a second die. The first layer, that is, the glide layer made of a polymer blended with the additive is advantageously 200 – 500 μm thick. The coextrusion of the layers may take place in a dual-orifice die almost simultaneously or, alternatively, extrusion is carried out in separate steps. However, the invention is not limited to any specific tube manufacturing method or technique, but rather, the wire guide tube can be fabricated using any method giving the desired end result. Obviously, the tube may comprise even multiple layers. When so desired, the wire guide tube may be coated with a flexible or insulating sheath, but this kind of protection is rarely necessary. While any other suitable polymer could be used in lieu of HDPE, this material offers good structural stiffness and easy blendability of the additives used in the extrusion process.